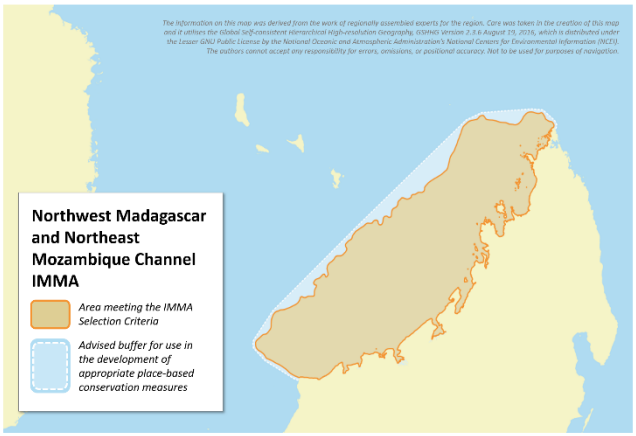

Area Size

120,614 km²

Qualifying Species and Criteria

Omura's whale – *Balaenoptera omurai*
Criteria B1

Antarctic blue whale – *Balaenoptera musculus intermedia*; Criteria A

Pygmy blue whale – *Balaenoptera musculus brevicauda*; Criterion A, C3b

Fin whale – *Balaenoptera physalus*
Criterion A

Humpback whale – *Megaptera novaeangliae*
Criteria B2, C1, C3b

Indian Ocean humpback dolphin - *Sousa plumbea*
Criteria A, B1

Melon-headed whale – *Peponcephala electra*
Criterion B2

Dugong – *Dugong dugon*
Criterion A

Sperm whale – *Physeter macrocephalus*
Criterion A

Northwest Madagascar and Northeast Mozambique Channel IMMA

Criterion D (2) - Marine Mammal Diversity
Balaenoptera acutorostrata, Balaenoptera bonaerensis, Balaenoptera musculus, Balaenoptera omurai, Balaenoptera physalus, Dugong dugon, Globicephala macrorhynchus, Grampus griseus, Indopacetus pacificus, Kogia sima, Lagenodelphis hosei, Megaptera novaeangliae, Peponocephala electra, Physeter macrocephalus, Pseudorca crassidens, Sousa plumbea, Stenella attenuata, Stenella longirostris, Tursiops aduncus, Tursiops truncatus, Ziphius cavirostris

Summary

The waters of the Mozambique channel, off the northwest coast of Madagascar, comprise a highly diverse and important region for marine mammals. A minimum of 23 marine mammal species have been documented here, including 6 baleen whale species, 16 toothed whales and dolphins, and the dugong. The area encompasses important habitats for breeding, feeding and migration, as well as small and resident populations for several species. Species listed in the IUCN Red List of Threatened Species include: Critically Endangered Antarctic blue whales (*Balaenoptera musculus intermedia*); Endangered pygmy blue whales (*B.m. brevicauda*); Endangered Indian Ocean humpback dolphins (*Sousa plumbea*); Vulnerable fin whales (*Balaenoptera physalus*), Vulnerable sperm whales (*Physeter macrocephalus*), and Vulnerable dugongs. Notably, a population of Omura's whales is resident in the area year-round and is likely regionally isolated. During a large-scale aerial survey, encounter rates for several species, including common dolphins (*Delphius delphis*) and Indo Pacific bottlenose dolphins (*Tursiops aduncus*), melon-headed whales (*Peponocephala electra*), and spinner or spotted dolphins (*Stenella sp.*) were particularly high on the shelf and slope habitats of the IMMA.

Description

This IMMA encompasses a stretch of the west coast of Madagascar from ca. 12˚S to 16˚S offshore to approximately 100 km. It encompasses a large variety of habitats, from coastal mangroves, coral reefs and sandy and rocky shores, to neritic continental shelf and pelagic deep-water habitats. The area includes the Nosy Be region from approximately 12.7˚S to 13.7˚S, including the islands of Nosy Be, Nosy Komba, Nosy Iranja and the Nosy Mitsio archipelago, where relatively extensive research on marine mammals has been conducted.

At minimum, 23 marine mammal taxa (22 species and 1 subspecies) have been documented in this area (Van Canneyt et al., 2010; Cerchio et al., in press). The IMMA encompasses important habitat in three specific zones, each with a distinct species, or species group, that satisfies a range of IMMA criteria. The habitat zones and associated species are as follows. The near-coastal zone: Indian Ocean humpback dolphin, Indo-Pacific bottlenose dolphin and dugong. The continental shelf zone: Omura's whale, humpback whale, dwarf minke whale, spinner dolphin, pantropical spotted dolphin, and Indo-Pacific bottlenose dolphin. And the offshore continental slope and abyssal plain deep-water zone: Antarctic blue whale, pygmy blue whale, fin whale, Antarctic minke whale, spinner dolphin, pantropical spotted dolphin, Fraser's dolphin, common bottlenose dolphin, Risso's dolphin, short-finned pilot whale, melon-headed whale, killer whale, false killer whale, sperm whale, Cuvier's beaked whale, Longman's beaked whale, dwarf and pygmy sperm whale.

Much of the coastline is remote and undeveloped, yet there are several highly-developed and heavily-populated centres, including the port of Mahajanga and the tourism hubs of the Nosy Be region and Antsiranana. Bycatch of small cetaceans has been documented in coastal artisanal fisheries and although hunting appears to be much less prevalent than it is in the southwest region, it is not entirely absent (Cerchio et al. 2014; 2015b). Currently there is extensive seismic exploration planned throughout this entire region which presents a distinct threat to sensitive populations of cetaceans (Cerchio et al., 2019). There is also coastal industrial development in the form of mining for Rare Earth Elements that has the potential to pollute coastal waters in the Nosy Be region (Cerchio et al., 2019).

Criterion A: Species or Population Vulnerability

Indian Ocean humpback dolphin, *Sousa plumbea* (IUCN Red List EN, Braulik et al., 2015; 2017). The conservation status of the Indian Ocean humpback dolphin is reported to be heterogeneous along the west coast of Madagascar; population(s) in the southwest are highly impacted (where active hunting occurs in the waters of the Vezo people), whereas population(s) in the northwest appear to be healthier and more abundant (Cerchio et al., 2009; 2014; 2015b; Razafindrakoto, 2004). The regions encompassed by the IMMA, well documented around the Nosy Be, Nosy Iranja and Nosy Mistio area, appear to be a haven for humpback dolphins relative to much of the other parts of their range in Madagascar.

Antarctic blue whale, *Balaenoptera musculus intermedia* (IUCN Red List CR, Cooke 2018a) and SWIO pygmy blue whale, *Balaenoptera musculus brevicauda* (IUCN Red List EN, Cooke 2018b). Passive acoustic monitoring from recording sites on the shelf break near Nosy Be indicated the presence of both species off northwest Madagascar (Cerchio et al.,) 2018b. Some acoustic detections were high signal-to-noise ratio indicating presence within 10km of the shelf break, whereas it was suspected that most detections were within 100km of the coast. The offshore extent of the IMMA boundary was chosen to roughly encompass the likely range at which blue whales were detected acoustically during the austral winter and fall migrations, but it is likely that whales range further offshore into the Mozambique Channel (Cerchio et al. 2018).

Sperm whales, *Physeter macrocephalus*, listed as *Vulnerable* (Taylor et al. 2008) have not been a focus of study in the waters of northwest Madagascar, however they use the deep offshore waters of the IMMA regularly and were encountered over the slope habitat during REMMOA aerial survey. Visual surveys of deep waters in Nosy Be resulted in encounters near the 2000m depth contour, and acoustic monitoring produced numerous detections.

Dugong, *Dugong dugon*, IUCN Red List Vulnerable (Marsh and Sobtzick, 2015) is also encountered in the area (Cerchio et al. 2012; Van Canneyt et al, 2010). The species is thought to have been historically widespread throughout Madagascar, but believed to be heavily exploited to the point that sightings of live animals are very rare. Population status is generally uncertain and it is possible/likely to have been extirpated throughout much of its former range (Cooke et al. 2003; Cerchio et al., 2012; Davis et al., in press). Interview surveys with fishers along the west coast of Madagascar indicated decline in numbers of sightings and individuals captured in hunting and by-catch during the decade 2000-2010, and shifts in the relative distribution of reports over time, suggesting that populations in some locations may be more impacted or closer to extirpation (Cerchio et al. 2012).

Criterion B: Distribution and Abundance
Sub-criterion B1: Small and Resident Populations

Omura's whale, *Balaenoptera omurai* – Existing data, much of it recent (including year-long acoustic monitoring, visual surveys, photographic identification, and satellite telemetry), indicate that this is a resident, non-migratory population whose distribution is likely determined by local shallow water ecological processes and patchy and ephemeral prey resources. Furthermore, this population of Omura's whale may be isolated within a fragmented oceanic/global range for the species. The boundaries of the area encompass the range documented by boat surveys and satellite telemetry data including the offshore extent of documented movements, and likely most of the habitat for this population as indicated by habitat suitability modelling (Cerchio et al., 2015a; 2018a). Indian Ocean humpback dolphin, *Sousa plumbea*. The latitudinal range of the IMMA encompasses most, if not all, of the coastal habitat for this species within that area where hunting pressure is believed to be least in Madagascar (Cerchio et al., 2009, 2014, 2015b; Razafindrakoto 2004). Dugong, *Dugong dugon*- There are interview accounts of relatively recent sightings, bycatch and hunting in the northwest Nosy Be region (Cerchio et al. 2012) and in the Diana region in the extreme northwest (C3-MIOIP, 2010b; Davis et al.., in press), and aerial survey documentation of live sightings between Mahajanga and Bay of Sahamalaza in 2009 (Van Conneyt et al., 2010). These data suggest that the northwest of Madagascar may constitute a range where a remnant viable population remains, but is still under hunting and bycatch pressure and likely in decline. During the REMMOA aerial survey (between mid December 2009 and early January 2010) relative density of dugong was estimated at 0.10×10^{-2} individuals.km^2 (CV: 74%), corresponding to probably fewer than 200 dugongs in this area (Laran et al., 2012). The coastal boundaries of the area encompass all of these sites and the majority of the most recent sightings and documentation where a remnant viable population may remain in Madagascar (Cooke et al., 2003; C3-MIOIP, 2010; Van Canneyt et al., 2010; Cerchio et al., 2012; Davis et al., in press).

Criterion C: Key Life Cycle Activities
Sub-criterion C1: Reproductive Areas

Humpback whale, *Megaptera novaeangliae* – Madagascar is a well-documented breeding area for humpback whales, and small boat surveys indicate that they are common in coastal waters of the Nosy Be region during the mid to late breeding season; year-long acoustic monitoring in the deep offshore waters of the Nosy Be region indicates near continuous presence of humpback whale song from early July to mid-November (Cerchio et al. 2018b; in press).

Antarctic blue whale, *Balaenoptera musculus intermedia* – Year-long acoustic monitoring in the deep offshore waters off the Nosy Be region indicated the presence of Antarctic blue whale song off northwest Madagascar throughout the Austral winter from June to September, suggesting previously unrecognized breeding season habitat (Cerchio et al., 2018b). Fin whale, *Balaenoptera physalus* – Year-long acoustic monitoring in the deep offshore waters off the Nosy Be region indicates the presence of fin whales during the late Austral winter, from early August to mid-September (Cerchio et al 2018b). The timing of fin whale song suggests a later arrival than Antarctic blue whales and a lower rate of occurrence and occupancy, suggesting the northern extent of breeding habitat.

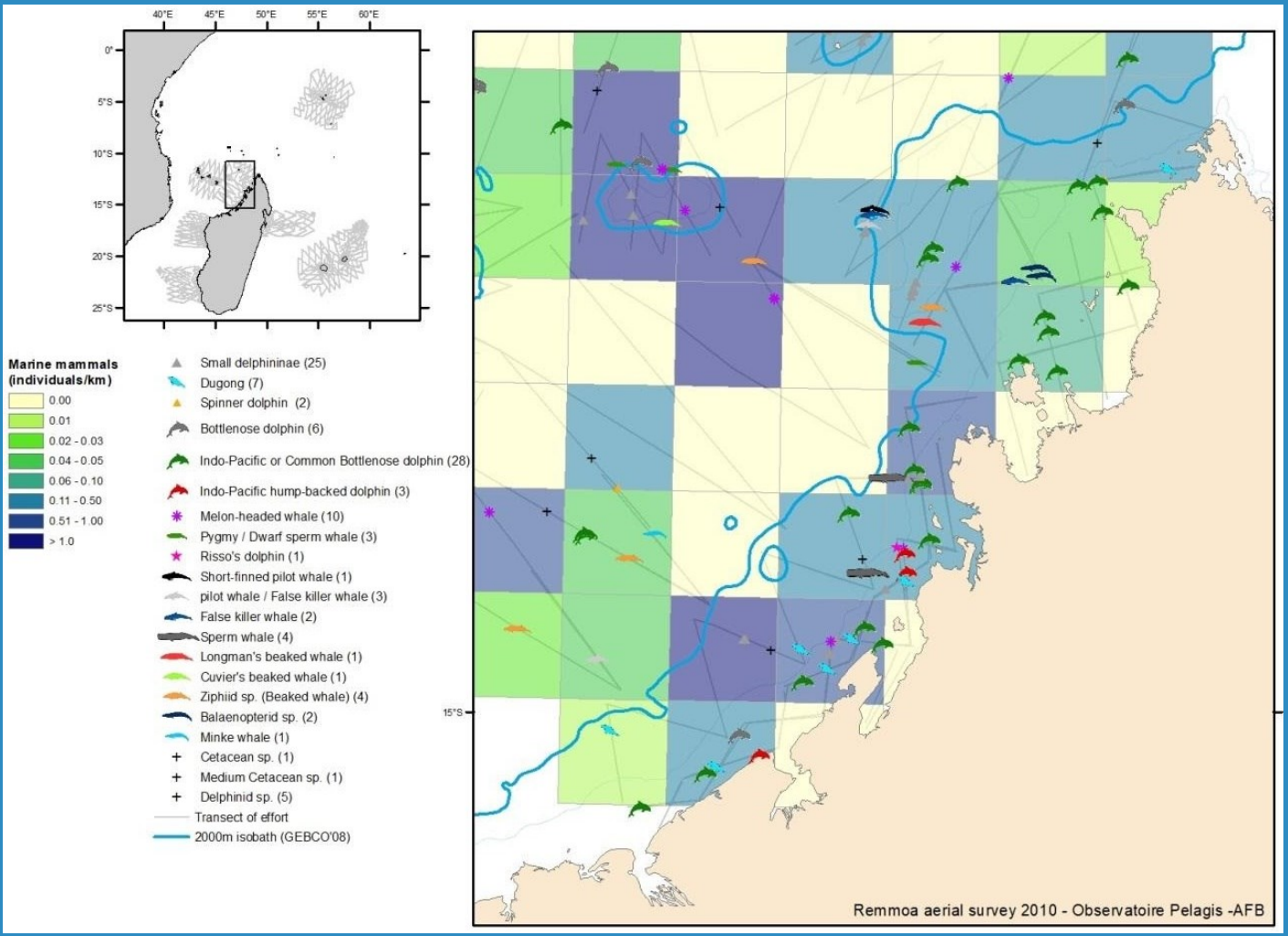

Figure 1: Sightings of cetaceans collected on effort during REMMOA aerial survey in the North of Mozambique Channel (between mid December 2009 and early January 2010) detailed by species or taxa and encounter rate of individual (for cell with up to 50km of effort - Unpublish map Pelagis-AFB; Van Canneyt et al, 2010)

Criterion C: Key Life Cycle Activities
Sub-criterion C3: Migration Routes
C3b – Migration / Movement Area

Pygmy blue whale, *Balaenoptera musculus brevicauda* – Year-long acoustic monitoring in the deep offshore waters of the Nosy Be region indicates presence of the Madagascar-type pygmy blue whale song with bi-modal peaks of singing activity during May-July and October-January (Cerchio et al 2018b). This pattern suggests a previously unrecognized migratory corridor between summer feeding and winter breeding grounds south and north of Madagascar, respectively. This migratory corridor likely connects feeding habitat on the Madagascar Plateau and Ridge (Best et al. 2003) and likely breeding habitat off Kenya and the Seychelles area (Branch et al. 2007, Barber et al. 2016). Humpback whale, *Megaptera novaeangliae* – Satellite telemetry data indicates that this area of coast is a late season migratory corridor for humpback whales (Fossette et al 2014, Dulau et al 2017).

Criterion D: Special Attributes
Sub-criterion D2: Diversity

A minimum of 22 species of cetaceans and the dugong have been documented in the Nosy Be region (Van Canneyt et al. 2010; Cerchio et al., in press). In addition to the species described above for other criteria, the following species are included for this criterion. Dwarf minke whale song vocalizations were detected on several days during non-systematic review of acoustic data from continental shelf waters around Nosy Be; it is possible that future analyses will indicate regular presence during the Austral winter, and thus in breeding habitat (Cerchio et al., in press). Spinner dolphins are the most often sighted species by number of individuals in the continental slope and offshore areas (Cerchio et al., 2014). Pantropical spotted dolphins are frequently sighted in offshore areas during surveys around Nosy Be, at times in groups exceeding 500 individuals, and in combination with spinner dolphins, as well as on

the continental shelf in smaller-sized groups (Cerchio et al. 2014; in press). Fraser's dolphin were occasionally encountered in deep waters around Nosy Be, as were short-finned pilot whales, with groups of up to more than 40 individuals (Cerchio et al. 2014; in press). Melon-headed whale and false killer whale were also occasionally encountered in shelf waters by tourists (Cerchio, unpublished data). During the REMMOA aerial survey, bottlenose dolphins (unclear if common or Indo-Pacific), have a relative density of 7 x 10^{-2} individuals.km^2 (CV: 30%) over the shelf area of Comoros and the Malagasy coast (Laran et al., 2012) while *Stenella spp.* dominate the community with a density peaking to more than 30 x 10^{-2} individuals.km^2 (CV: 59%) over the slope strata (Laran et al, 2012). Nevertheless, most of the large Delphinidae (*Tursiops spp.*) were encountered along the Malagasy coast, while *Stenella spp.* concentrated around the Comoros archipelago. Melon-headed whales, encountered in large groups resulting in a density of 50 x 10^{-2} individuals.km^2 (CV: 42%) for small blackfish (Globicephalinae) over the slope of this area and around the Comoros islands. The slope area has also sperm whale, beaked whales, Cuvier's and Longman's beaked whale, false killer whale, short-finned pilot whale and *Kogia spp.* (Van Canneyt et al., 2010; Cerchio et al., in press).

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